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ABSTRACT

This paper describes the Multiple Assessment Programs and Services (MAPS) Placement Research Service. Students entering nonselective colleges show a wide range of ability. The College Board offers these colleges a number of tests of reading, writing, and mathematics skills for use in placing students appropriately. The MAPS Placement Research Service is a new service available to colleges that use these tests. The service analyzes test score and criterion data supplied by the college and produces a report based on the data. The college can use the information to establish decision rules for placing students into courses or to counsel individual students in their selection of courses. The MAP Placement Research Service report consists entirely of tables, is organized by groups of students, and includes the score distributions of all predictors and criteria and the intercorrelations of all predictors and criteria in each group of students. The user can request a series of detailed analyses of the relationship between particular predictors and criteria. For each analysis, the user specifies the group of students, the predictor or predictors, and the criterion measure. Tables, smoothing procedures, and sample sizes are discussed. A sample MAPS Placement Research Service Report is appended. (PN)

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The MAPS Placement Research Service

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A paper to be presented at the Annual Meeting of the National Council on Measurement in Education, San Francisco, April, 1986.

Most people who think about educational testing probably think of the College Board as the organization responsible for the admissions tests used at selective colleges--the Scholastic Aptitude Test and the College Board Achievement Tests. However, many colleges and community colleges are not at all selective. The students entering these colleges show a very wide range of ability in reading, writing, and mathematical skills, and they need to be placed in courses appropriate to their ability. The College Board offers these colleges a number of tests of reading, writing, and math skills, for use in placing students appropriately. These tests are part of "MAPS", which stands for "Multiple Assessment Programs and Services." The MAPS Placement Research Service is a new service that the College Board is making available to colleges that use these tests. The service consists of analyzing test score and criterion data supplied by the college and producing a report based on the data. The college can use the information in the report to establish decision rules for placing students into courses or to counsel individual students in their selection of courses.

A MAPS Placement Research Service report consists entirely of tables. We considered supplementing the tables with computer-produced graphs, but we decided that the information the Placement Research Service produces could be presented quite clearly without any graphics. The additional benefit did not justify the additional costs. The first time each type of table appears in the report, it is accompanied by a brief explanation of the statistics it contains, on the page just before the table.

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A MAPS Placement Research Service report is organized by groups of students--first, the total group of all students, followed by whatever subgroups the user has specified. The system will produce separate analyses for up to six subgroups. The report always includes the score distributions of all predictors and criteria and the intercorrelations of all predictors and criteria in each group of students. Then, in addition, the user can request a series of detailed analyses of the relationships between particular predictors and criteria. For each analysis, the user specifies the group of students, the predictor or predictors, and the criterion measure.

For each single-predictor analysis the user requests, the system prints out four types of tables. The first is a two-way table of observed data--a contingency table showing how many students had predictor scores in a particular interval and criterion scores in a particular interval. The user can either specify the score intervals or let the system do it for him.

The second type of table is a 2x2 table of observed data. This is simply a reduced version of the full two-way table, and it is optional. In order to get it, the user has to specify a cutoff score on the criterion measure. The user may also specify a cutoff on the predictor, or else let the computer make the choice. (The computer will choose the predictor cutoff score that makes the marginal frequencies on the predictor as close as possible to what they are on the criterion.)

The third type of table for each single-predictor analysis is an expectancy table. This is a table of estimated conditional probabilities, for example, the probability that a student with a score of 41 to 45 on the writing test will obtain a grade of C or better in the regular first-year

English composition course. This table is probably the most useful and the most interesting of the tables the system produces. Useful, because it offers a kind of information that the test users can easily apply and understand. Interesting, because the statistical procedure for estimating the probabilities is new. (I'll say more about the expectancy tables later.)

The fourth type of table for each single-predictor analysis is a prediction equation, computed by ordinary least-squares regression. In addition to the prediction equation, the table also shows the sample size, the correlation, and the residual standard deviation.

The tables that the system produces for a multiple-predictor analysis are somewhat different. There is no expectancy table. We considered the options for producing an expectancy table based on multiple predictors. Conditioning on all predictors would be far too complex for the users. We could condition on the best two predictors. Or we could condition on the composite predictor that predicts best in the sample of students. None of these options seemed very attractive, and we finally decided against all of them. We don't produce an expectancy table for a multiple-predictor analysis. The user can get an expectancy table for a composite of two or three equally-weighted predictors by requesting a single-predictor analysis with the sum of these two or three variables as the single predictor.

The tables for a multiple-predictor analysis begin with a table of stepwise regression equations, starting with the best single predictor and adding one predictor at a time. If any of the specified predictors make too small a contribution, they will not be included. Instead, the computer will print out a message that says "The following predictors were not included in the prediction equation because their additional predictive power in this

group of students was too small." However, the table does include a prediction equation that includes all the specified predictors, weighted equally. Of course, if the predictors are on different scales, their effective weights will not be equal. But in most cases, this equal-weighted composite will produce almost as high a correlation as the empirically derived weights.

Each prediction equation is accompanied by two correlations--the multiple R in the sample and an estimate of what the correlation using those same prediction weights would be in the population.

The second type of table produced for each multiple-predictor analysis is a two-way table of predicted scores vs. actual scores on the criterion measure, for the students in the sample. One feature of the data that is quite apparent from this table is how much less variation there is in the predicted scores than in the actual scores.

The third type of table for each multiple-predictor analysis is a 2x2 table of predicted scores vs. actual scores on the criterion measure, for the students in the sample. Again, this table just presents a regrouping of the information in the previous table. The 2x2 table shows the number of "hits" and "misses", in the sample used to derive the prediction equation. To get this table, the user has to specify a cutoff score on the criterion measure. This cutoff score is applied to both the predicted scores and the actual scores.

The feature of the MAPS Placement Research Service that is most interesting from a statistical point of view is the way the expectancy tables are produced. They are produced by smoothing the observed two-way tables, using an iterative log-linear maximum-likelihood procedure developed

at ETS by Paul Rosenbaum and Dorothy Thayer. The smoothed table that this procedure produces has cell frequencies that are generally not whole numbers. Therefore, a cell frequency in the smoothed table is a fractional number of students. This fractional cell frequency can be interpreted as an estimate of the expected number of students in that cell, averaging over repeated samples. That is, we consider the students in the observed two-way table as a sample from a population of students, and we try to estimate what the two-way table would look like, averaged over repeated samples from this population. Then, by summing over values of the criterion measure above a certain level, we get an estimate of the probability that a student from this population, with a predictor score in a certain interval, would achieve at least a certain score on the criterion measure.

The smoothing procedure offers a choice of models--stronger models for sparse data, weaker models for denser data--but none of the models is so strong as to specify the shape of the distribution. We no longer have to pretend that the world is bivariate normal. Each model produces the "smoothest" solution that preserves certain aspects of the original unsmoothed two-way table. The unsmoothed two-way table is the same table the system prints out as the "two-way table of observed data"; it contains the same data, grouped into the same intervals on each variable. The strongest model preserves only the means, the variances, and the correlation between the predictor and criterion. That is, the smoothing is constrained so that the smoothed two-way table will have the same means, variances, and correlation between variables as the unsmoothed table, but everything else gets "smoothed out". We would generally not use this strong a model, however. The model we typically use in the Placement Research Service

preserves the mean, the variance, and the skewness of each variable, and also the correlation between the two variables. There are weaker models that preserve the marginal frequencies of the unsmoothed table, but we would not use these models unless the sample were so large that the marginal distributions in the unsmoothed table were already fairly smooth.

The handout contains an example of an observed two-way table and the expectancy table produced from it. You can see that even where there is a zero cell frequency in the observed table, the smoothing procedure has estimated a positive probability of finding a student in that cell. (That is, the corresponding cell in the expectancy table does not show the same probability as the cell to its left.)

In the MAPS Placement Research Service we deal with the problem of small sample size in two ways. First, we require data on at least 25 students for a single-predictor analysis. For a two-predictor analysis, we require 50 students; for three predictors, 75 students, and so on. These students must have data on the criterion measure and all the predictors. These sample size requirements apply to analyses for subgroups of students as well for the total group. However, with as few as 25 students in a two-way table, there may be very few--possibly none at all--in a particular score interval on the predictor. Yet, we are reporting conditional probabilities for students in that score interval. We do it by using a two-way smoothing procedure that, in effect, borrows information from the other score intervals. And in this procedure we use a fairly strong model, with only seven parameters to be estimated from the data. This two-way smoothing procedure is our second way of dealing with small samples.

We deal with the problem of highly correlated predictors by emphasizing analyses based on single predictors and equally-weighted combinations of predictors. The user can request a single-predictor analysis based on an equally-weighted composite predictor, and the system will create the composite predictor and perform the analysis. Also, every multiple-predictor analysis includes a prediction equation based on equal weights for the predictors.

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Handout for "The MAPS Placement Research Service"

Samuel A. Livingston
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Presented at the Annual Meeting of the National Council on Measurement in Education, San Francisco, April, 1986.

MAPS PLACEMENT RESEARCH SERVICE

ANYWHERE COLLEGE 10/25/85

GROUP: MATH 101

TWO-WAY TABLE OF OBSERVED DATA: NUMBER OF STUDENTS IN EACH SPECIFIED SCORE INTERVAL

PREDICTOR: COMPUTATION
CRITERION: MATH GRADE

	MATH GRADE					
COMPUTATION	0.00 TO 0.00	1.00 TO 1.00	2.00 TO 2.00	3.00 TO 3.00	4.00 TO 4.00	TOTAL
70.00 TO 80.00	0	0	0	0	0	0
60.00 TO 69.00	0	0	1	0	1	2
50.00 TO 59.00	1	0	4	2	0	7
40.00 TO 49.00	5	4	5	1	1	16
30.00 TO 39.00	5	1	0	1	0	7
20.00 TO 29.00	0	1	0	0	0	1
TOTAL	11	6	10	4	2	33

MAPS PLACEMENT RESEARCH SERVICE

ANYWHERE COLLEGE 10/25/85

GROUP: MATH 101

EXPECTANCY TABLE: ESTIMATED PROBABILITY OF ACHIEVING AT LEAST THE SPECIFIED SCORE ON THE CRITERION MEASURE.

PREDICTOR: COMPUTATION
CRITERION: MATH GRADE

	MATH GRADE				
COMPUTATION	AT LEAST 0.00	AT LEAST 1.00	AT LEAST 2.00	AT LEAST 3.00	AT LEAST 4.00
60.00 TO 69.00	1.00	.97	.89	.65	.23
50.00 TO 59.00	1.00	.88	.70	.40	.10
40.00 TO 49.00	1.00	.68	.42	.17	.03
30.00 TO 39.00	1.00	.45	.19	.05	.01
20.00 TO 29.00	1.00	.27	.07	.01	.00

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